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THE EFFECT OF SELECTED VISUAL TRAINING PROCEDURES ON THE VISUAL FORM FIELD

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C. W. CRANNELL
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CONTRACT No. AF 18(600)-25
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WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

This report describes an investigation conducted at Miami University, Oxford, Ohio, under Contract No. AF18(600)-25, between Miami University and the Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. The task, "Size of Form Field as a Factor in Check Reading Aircraft Dials," is carried under Project 7186, "Visual Presentation of Information," Dr. James M. Vanderplas, Project Scientist. The task was initiated by Mr. J. M. Christensen, Psychology Branch, Aero Medical Laboratory. Supervision of testing procedures, and analysis was performed by Dr. C. W. Crannell, Miami University.

ABSTRACT

An experiment was performed to examine the possibility of increasing the area of the visual form field through certain training procedures. A comparison was made between training to read groups of digits exposed tachistoscopically and training to perceive single digits exposed to the periphery of the retina.

Tests of the effectiveness of these two types of training were made in terms of pretests and posttests of (1) reading speed and accuracy, (2) ability to check read a panel of simulated aircraft instrument dials exposed tachistoscopically, (3) ability to perceive digits in the peripheral areas, and (4) ability to transfer the perceiving of peripherally exposed objects to symbols other than digits.

The results of these training procedures were found to be uniformly negative with regard to gain from pretests to posttests, with the exception of a certain degree of transfer from training with peripherally exposed digits to perception of Landolt rings, which were not used in training.

It is concluded that perceptual training with extremely simple stimuli, such as those used in this investigation, is unlikely to result in a general improvement in form vision or in reading proficiency. These results contradict those found elsewhere in the literature.

Research involving more elaborate stimulation procedures is planned.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

Jack Bollerud

JACK BOLLERUD
Colonel, USAF (MC)
Chief, Aero Medical Laboratory
Directorate of Research

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THE EFFECT OF TACHISTOSCOPIC AND PERIMETER TRAINING ON THE VISUAL FORM FIELD

I. INTRODUCTION

Several studies have appeared recently in which evidence is presented that, through specialized training, the perceptual acuity for form may be expanded toward the periphery of the visual field (1, 2, 4, 5, 6, 8). Two diverse methods have been found to yield such results: (1) training in the perception of increasing numbers of digits or other symbols exposed tachistoscopically, and (2) training in the perception of digits or other symbols using a perimeter. The evidence indicates that such training results in generalized ability to be attentive to stimuli which appear in the periphery of the visual field and to read more rapidly and accurately.

From the practical standpoint, these findings suggest promise of wide applicability. In flying, automobile driving, and many other activities any substantial and reasonably enduring increase in the capacity to respond to peripheral stimuli while the direction of vision is fixated elsewhere would serve to reduce the problems created by the need for constantly shifting the eyes during such activities. Such increased proficiency would be of particular value to pilots, who frequently must pick up and react to peripheral cues in split seconds in order to save their airplanes and their lives. A simple training procedure for accelerating the general reading rate (if comprehension were not adversely affected) would have great value.

The experiment presented in this report deals with an attempt to establish the basis for and extent of transfer to other tasks from perimeter and tachistoscopic training. A series of experiments is being conducted which should provide additional information on the type of results which may be expected.

II. PROCEDURE

A. Preliminary Tests

All subjects were given the same preliminary test battery. The subjects were men recruited from various classes at Miami University. Each subject was first tested with the Bausch and Lomb Ortho-Rater to screen out those whose vision did not meet minimum qualifications for this experiment. Minimum near acuity required was a score of 9, 9 and 9 for right, left, and both eyes respectively (or one step below the established norm of 10, 10 and 10). Men were rejected as subjects if any near vision score was less than 10 and at the same time there was a far vision score of less than 9. Because recruitment of many college men with emmetropic vision, expecially for such extended

experimentation, was not possible, higher visual standards could not be exacted. The few cases with a minor anomaly of phoria or distance acuity were placed in different groups of subjects so as not to influence unduly the results of any one group.

After screening with the Ortho-Rater, each subject was required to supply biographical information, and a schedule of five weekly appointments was arranged.

The first preliminary test was a Dial Checking Test. Thirty-seven lantern slides (Figure 1) were used in this test. Each slide had 36 dial faces; on one slide all hands on the dial faces pointed in the same direction. This was called the "null" slide. On each of the other 36 a different dial face had its hand pointing to a position slightly different from the other 35. The size of each dial face, when projected, was 1 3/4" with a gap between dials of the same amount, making a total field of 18 1/4", or a visual angle of approximately 19^0 (with fixation at the center) perpendicularly to the outer edge of the field, or about 25.5^0 from the center to any corner. The illumination of the room was maintained at a brightness which made it just possible for the subject to read and mark his answer sheet without eyestrain. The open field of the lighted projector at the distance of the projection screen provided an illumination, measured with a Norwood exposure meter, of approximately 32 ft-c. This provides an estimate of the brightness of the white dials against their surroundings. Exposure time was .10 seconds, and the task of the subject was to indicate on a prepared answer sheet which dial face had the deviating pointer, or whether none of the 36 deviated. Appendix I shows the complete instructions for this test. Each slide with a deviating pointer was presented twice, and the null slide was shown 8 times, making a total of 80 presentations. A prepared random series of presentations was constant for all subjects.

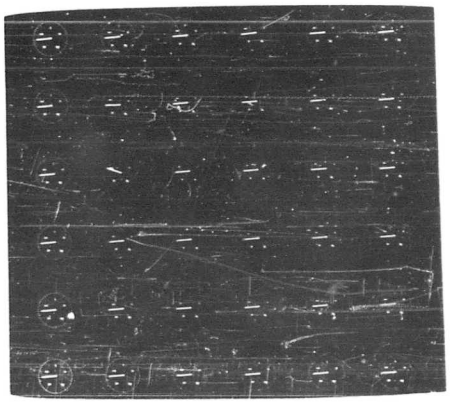

Figure 1: Type of slide used in Dial Checking Test

The second preliminary test, administered directly after the dial checking test, was the Robinson and Hall "Test of Reading Ability for History" (7). For half the subjects, Form Canada was employed, for the other half, Form Russia.

The third preliminary test was a test of peripheral vision, using a Ferree-

Rand Perimeter, Bausch and Lomb Co., Type 71-57-13. This was fitted with an Expo-Matic device which held a cardboard slide containing in random order the numbers from 1 to 9. The numbers were 3/8" in height. Exposure was made by covering the number from the front with a small square of gray cardboard attached to a stick. Exposure of each number was about one second, the length of exposure being controlled by the experimenter who operated the cardboard cover. Tests were made for each eye separately, for the four coordinates, temporal, nasal, superior and inferior. Each eye was tested alternately to prevent tiring. Exposures were begun at 24°, at which point three different numbers were exposed, unless the subject missed one. As soon as a number was missed, the Expo-Matic device was moved in two degrees, and three new numbers were given. This continued until the subject got three numbers right; then the device was moved out until a number was missed. The score was the maximum number of degrees at which three numbers were read correctly. If three numbers were not read correctly at 10°, the score was taken to be 8°, since it was not possible to move the Expo-matic nearer the center than 10°. Complete instructions are shown in Appendix II.

A fourth test was also attempted, involving an effort to measure the width of the "phi field". An apparatus was contructed which exposed a small vertical white bar and simultaneously a red circle, set so that the apparent movement of the bar would be to the left as the circle appeared to move to the right. The pair of bars and pair of circles used to effect these exposures could be moved apart slowly, and the task of the subject was to tell when he no longer saw any apparent movement of either or both objects. Because of insurmountable problems, both in making the subjects understand how to verbalize their reports, and in training the experimenters to run this test, the test failed to be of value, and its use is reported merely for the record.

B. Group E-1: Tachistoscopic Training

Twelve subjects completed the training in this group. The device used for this training was the Renshaw Tachistoscopic Trainer, manufactured by the Stereo Optical Company. Each subject was first given a detailed sheet of instructions to read, which explained the purpose of the experiment. Complete instructions for group E-1 are shown in Appendix III. After reading these instructions, the experimenter instructed the subject in the operation of the Tachistoscopic Trainer, using a series of 15 three-digit numbers. Exposure time was constant at .04 seconds. The subject then was run through a series of 15 four-digit numbers. The record was kept in a prepared notebook in which the subject himself entered the number he perceived, and the correct number as seen with unspecified length of exposure. Each subject checked his own record. If time remained, the subject worked with five-digit numbers.

On the second day the subjects were given three sets of 15 cards, containing four, five and six digits, in that order. If for the lowest number of

digits, 12 or more cards were correct, the subject progressed on the third day to five, six and seven digits. Progression was determined in this manner for all subsequent days, on the basis of at least 12 cards correct out of 15 for the easiest of the three series. If a subject missed 9 or more on the easiest series for two consecutive days, he reverted to the next easier series. The record was checked daily by the experimenters, who also observed the work of the subject for a few moments each day. As a rule, five such trials were held one week, and four the next. On Friday or Saturday of the second, fourth, sixth and eighth week of training, the dial checking test consisting of a series of 40 slides was repeated. Because of occasional illness and vacation periods, there were sometimes 8 rather than 9 training sessions between bi-weekly test periods. However, each subject completed 42 training sessions before the final tests.

C. Group E-2: Perimeter Training

Twelve subjects completed training in this group. The Ferree-Rand Perimeter and Expo-Matic device were used for daily training sessions, similar in length and scheduling to those of Group E-1. Each eye was given training in reading peripherally presented numbers along the four coordinates. Complete instructions are shown in Appendix IV. During the exposure of about one second, the number in the Expo-Matic device aperture was wiggled back and forth twice by hand. On the first day training was begun at 4° less than the score of the first test, according to eye and coordinate, but not less than 10° from the center. Three numbers were presented according to a prepared random order, and if all were correctly seen, the device was moved out two degrees for a second set of numbers, and so on until a number was missed. In working with the temporal visual fields (nasal retinal areas), it was necessary to make adjustment for, and to test beyond, the blind spot region. For the task of this experiment, this region was generally found to fall between 16° and 18°. There were certain individual differences in its extent and location.

As with Group E-1, 42 training sessions were held, with a bi-weekly test on 40 dial checking slides.

D. Group C-1: Control Group

Nine subjects completed these tests. These subjects reported every other week and merely took the dial checking test of 40 slides administered to all other subjects.

E. Group C-2: Control Group

Six subjects completed training in this group. These subjects reported once a week. On the first, third, fifth, seventh and ninth sessions they were tested with 80 dial check slides which had black markings on white instead of the white-on-black used for the regular tests. On the second, fourth, sixth and eighth sessions they were first tested with 40 black-on-white slides, followed by the same 40 white-on-black slides used for the other groups.

F. Final Tests

All subjects took the same final tests. These included the 80 slide dial checking test, the Robinson & Hall Reading Test (whichever form had not been taken as a preliminary test), and a repetition of the initial perimeter test. In addition, a special slide was constructed for use in the perimeter containing 8 Landolt Rings, open at 8 different positions. Width of the line used for the ring was matched with the width of the testing numbers used, and the break in the rings was made so as to be visible with direct fixation at the same distance that the training numbers could be read. A final perimeter test was then made, using these rings in place of the numbers.

III. RESULTS

A. Group E-1: Tachistoscopic Training

Table 1 shows the results of the tachistoscopic training of Group E-1. Data for the first training session were not considered, because the subjects were receiving instructions from the experimenters and were learning to operate the apparatus. In most cases this required so much time that only a very few cards with five digits could be used. As the table shows, on the second day all but one subject, No. 8, were able to respond correctly to at least 8 of the 15 cards with five digits, and all but four of them could get at least 12 out of 15.

TABLE 1

INDIVIDUAL DIFFERENCES IN TACHISTOSCOPIC TRAINING
GROUP E-1

	Number of Digits Presented																							
	5			6			7			8			9			10								
	Number Correct out of 15 Trials																							
Subj. No.	4	8	12	4	8	12	4	8	12	4	8	12	4	8	12	4	8	12						
	Session on Which Achieved																							
1	2	2	2	2	2	2	6	7	10	17	25	*	18	*	*	*	*	*						
2	2	2	4	3	4	4	10	35	*	*	*	*	*	*	*	*	*	*						
3	2	2	3	4	14	28	16	39	*	38	*	*	*	*	*	*	*	*						
4	2	2	2	2	4	6	6	11	11	13	17	31	14	26	*	25	*	*						
5	2	2	2	2	3	6	7	15	39	40	*	*	*	*	*	*	*	*						
6	2	2	2	2	2	2	2	2	15	8	14	42	16	38	*	*	*	*						
7	2	2	2	2	3	5	2	16	27	30	42	*	42	*	*	*	*	*						
8	2	3	15	8	18	41	[illegible]	*	*	*	*	*	*	*	*	*	*	*						
9	2	2	2	2	2	2	3	4	15	14	20	31	15	31	39	38	*	*						
10	2	2	6	3	6	9	11	18	27	25	29	*	31	41	*	*	*	*						
11	2	2	2	2	2	4	6	8	30	24	*	*	40	*	*	*	*	*						
12	2	2	2	2	2	2	2	6	9	14	*	*	34	*	*	*	*	*						

*Not attained by subject

Subject No. 8 was the poorest learner, and required 15 sessions to get 12 out of 15 right with five digits; he never succeeded in getting 8 out of 15 when there were seven digits. The two best subjects, Nos. 4 and 9, were able to get at least 4 out of 15 with ten digits before the conclusion of training. Wide individual differences in success of the training are revealed by this table.

Figure 2 presents the data for this group in learning curve form. Accuracy with four digits was achieved quickly, and no subjects were using these numbers after the fifth day. The reading of five digits was not perfected by all 12 subjects until the 39th day. The reading of seven-digit numbers improved rapidly throughout the training period, but was not perfected, although the mean number being read by the 42nd session was better than 12 out of 15. No subject succeeded in getting any ten-digit numbers right until the 16th day although three subjects had been working with these numbers since the 11th session.

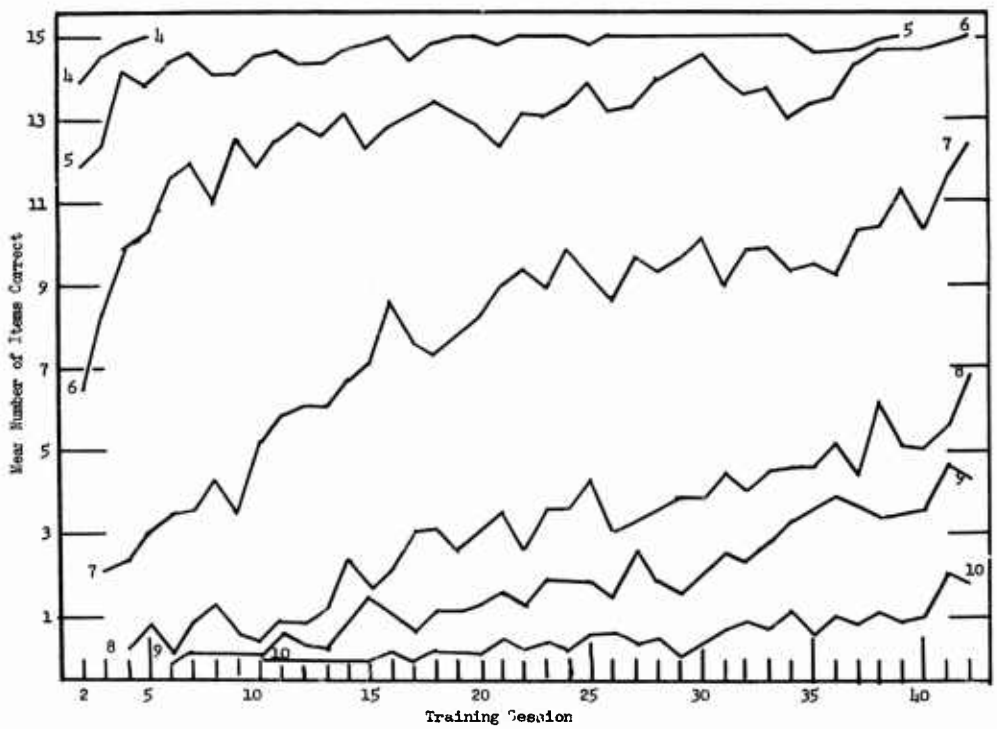

Figure 2. Learning Curves for Tachistoscopic Training

Table 2 presents under the columns headed "I" the data for the various preliminary tests, under columns headed "II" the data for the posttests, and under columns headed "G" the gains from pretests to posttests. The only significant gain in the table is for the perimeter test, average field, which has been computed in terms of sq cm. This gain is significant at the 5% level of confidence.

The method of computing the form field in terms of square centimeters should be discussed at this point. Measurements were made in terms of degrees on the Ferree-Rand Perimeter at a distance of about 33 cm (13 inches) from the cornea to the exposed number. At this distance, 5° is exactly equivalent to 3 cm along the perimeter. The score in degrees was determined by the highest number of degrees at which the subject called three out of three numbers correctly. Four measurements were made on each eye: right, left, inferior and superior. Of primary interest, however, is the binocular form field, the region in which form vision is effective with both eyes open. For determining this field two reasonable procedures exist: the first is to consider the maximum form field, or that area which would be covered by the maximum form field of both eyes, taking the widest measure of each eye independently; the second would be the minimum form field, or that area in which the form fields of both eyes overlap. In computation of the maximum form field, it is therefore possible to take the sum of the longest left, and longest right measurements, or A_L, multiplied by the sum of the longest inferior and superior measurements of B_L, multiplied by 1/2, multiplied by .36, which yields the area of a four-sided figure in terms of sq cm.[1]

A similar computation may be made for the minimum form field, or area of total binocular overlap. An average form field is the mean of the minimum and maximum fields, a measure less subject to chance fluctuations.

Of the various measures shown in Table 2, it is obvious that, by and large, 42 training sessions on the tachistoscope yielded little, if any, transfer to the other tasks. With regard to the Robinson-Hall Reading Test, the column headed "Form" shows that exact counterbalancing was not used. There are seven subjects who had "Canada" and five who had "Russia". The test manual (7) contains a table of percentiles which indicates that for university freshmen Form "Russia" is somewhat harder than Form "Canada". The 50th percentile is 198 lines for the former and 207 for the latter. A difference in this direction was not found in the present study, although the subjects were not freshmen. For the 19 subjects who took "Russia" as their initial form, the median was 214 lines; for the 19 who took "Canada", the median was 187 lines.

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[1]This procedure is derived from computing the sum areas of four right triangles, each having a side adjacent to one of the other triangles, or $\frac{1}{2}CD + \frac{1}{2}CE + \frac{1}{2}FD + \frac{1}{2}FE$. This reduces to $\frac{1}{2}(C + F)(D + E)$, and multiplication by .36 converts to sq cm. It is obvious that the form field has ellipsoid rather than straight line sides, but if A, or (C + F) is thought of as the major axis and B, or (D + E) as the minor axis of an ellipse, the area in ellipse form is $\frac{1}{4}\pi AB$. Any variation in area of the four-sided estimate of the form field will thus yield perfect correspondence to a true ellipse, or to a reasonably similar ellipsoid. For simplicity in computation, the conversion to an estimated ellipse has been avoided in this study.

TABLE 2

PRETEST (I) AND POSTTEST SCORES (II) ON THE
DIAL CHECKING, PERIMETER, LANDOLT RING AND READING TESTS, GROUP E-1

Subj. No.	Dial Checking I	Dial Checking II	Dial Checking G	Perimeter Test Average Field I	Perimeter Test Average Field II	Perimeter Test Average Field G	Landolt Rings Average Field II (Posttest only)
1	7	17	10	49	91	42	83
2	1	8	7	74	117	43	84
3	6	6	0	63	100	37	62
4	9	6	-3	92	95	3	52
5	11	10	-1	55	82	27	52
6	12	11	-1	150	165	15	183
7	10	8	-2	124	80	-44	79
8	11	9	-2	62	97	35	60
9	15	10	-5	60	166	106	156
10	9	8	-1	89	168	79	111
11	8	12	4	109	274	165	199
12	13	11	-2	84	125	41	94
M	9.3	9.7	0.3	84.3	130.0	45.7	101.3

READING TEST

Subj. No.	Form	Rate I	Rate II	Rate G	Accuracy I	Accuracy II	Accuracy G
1	C-R	275	335	60	79	58	-21
2	C-R	191	254	63	59	93	34
3	C-R	132	154	22	73	58	-15
4	R-C	218	220	2	69	100	31
5	C-R	211	204	-7	46	67	21
6	C-R	190	196	6	68	67	-1
7	R-C	208	231	23	68	68	0
8	R-C	241	224	-17	57	63	6
9	R-C	234	266	32	58	75	17
10	C-R	291	382	91	80	63	-17
11	R-C	211	280	69	63	74	11
12	C-R	155	154	-1	50	58	8
M		213.1	241.7	28.6	64.2	70.3	6.2

TABLE 3

EFFECT OF PERIMETER TRAINING
ON MAXIMUM AND MINIMUM FORM FIELD, GROUP E-2

Subj. No.		Training Session 1	7	14	21	28	35	42
				Maximum Field (Sq Cm)				
1		130	190	272	242	180	233	353
2		158	225	223	252	353	392	424
3		103	144	225	248	324	313	331
4		127	225	215	234	182	298	288
5		137	197	243	259	268	424	586
6		86	156	216	253	242	335	453
7		135	103	122	199	225	225	216
8		111	158	164	182	270	343	446
9		216	355	379	562	729	990	1108
10		150	292	282	590	518	880	778
11		202	265	331	356	418	467	529
12		119	206	234	318	187	282	335
	M	139	210	242	308	324	432	487
				Minimum Field (Sq Cm)				
1		86	151	182	162	166	158	253
2		94	190	144	169	224	234	350
3		75	91	182	197	242	232	243
4		94	137	156	156	108	212	215
5		86	130	190	182	198	281	424
6		65	117	135	207	181	234	313
7		84	78	91	104	182	151	174
8		71	86	97	117	232	234	389
9		115	225	272	520	650	741	985
10		130	243	158	357	302	547	618
11		111	140	232	242	324	343	356
12		94	135	164	277	151	216	174
	M	92	144	167	224	247	298	375

The means were 214.9 and 199.1 respectively. In another experiment, to be reported later, 24 subjects had "Russia" as their initial reading test, and 26 had "Canada". In this case the medians were 204 and 202.5, respectively. If, however, the gains for reading rate, shown in Table 2, are "adjusted" for the differences shown in the Robinson-Hall manual, by interpolation from their table of percentiles, so as to obtain the estimated score on the same form of the test, the mean gain becomes 29.6, and is significant at the 5% level of confidence. No similar manipulation of these scores yields significant differences for any other group in this study, and similar "adjustments" of the reading accuracy scores have no effect. In view of the fact that no data of this study suggest any differences in favor of the "Canada" form, such revisions of the reading scores are probably not called for. The reason that precise matching of reading test forms was not attained was that more emphasis was placed upon matching for the Dial Checking Test, which was considered more critical for the present experiment.

Because the Dial Checking Test was of greater interest than the others, a variety of sub-scores, in terms of peripheral accuracy, number of correct items per quadrant of dial field, and also additional scores in terms of the "near misses", were studied, but none of these provided indications of significant improvement. Furthermore, no relationships could be discovered between differential amount of success during the training period, and results of the pre- and posttests.

B. Group E-2: Perimeter Training

Table 3 shows some of the results of training for Group E-2. Maximum and Minimum form fields in sq cm are presented for the first training session, and for every seventh session. For both computations of the form field the mean increase in area is consistent, although individual fluctuations in the rate of increase are quite evident. Much of the variation within successive measurements on a given individual could be accounted for in terms of chance success in obtaining three out of three numbers correct in succession. The data for this group are presented in graphic form in Figure 3; only minor daily fluctuations in mean rate of improvement may be noted. Table 4 provides a comparison of the form fields in early training with those late in training. The averages for the first three and last three days are shown, and also the ratio of increase from the first three to the last three days. In general, the mean form field near the end of 42 sessions of training is over three times as large as at the start of training. One subject, No. 9, displays a very large increase in minimum form field, but in general the ratios of gains for both measurements are quite similar.

The pre- and posttest data for Group E-2 are given in Table 5. As would be anticipated, the gain in perimeter test scores is quite large, and highly significant (t is 5.49). Negative results are again apparent for the Dial Checking Test; studies of partial scores, which were also made as for Group E-1, also revealed no significant trends. With regard to the Robinson and Hall Reading Test, an error by the experimenter led to administration of the same form of the test twice to Subject No. 3. The reason for the phenomenal gain in reading rate of Subject No. 11 was discovered after

TABLE 4

COMPARISON OF FORM FIELD SIZE
BETWEEN FIRST THREE AND LAST THREE DAYS OF TRAINING, GROUP E-2

Subj. No.	Maximum Field A (Days 1,2,3)	Maximum Field B (Days 40,41,42)	Maximum Field Ratio B/A	Minimum Field A (Days 1,2,3)	Minimum Field B (Days 40,41,42)	Minimum Field Ratio B/A
1	113	330	2.9	83	223	2.7
2	184	357	1.9	120	285	2.4
3	132	348	2.6	86	252	2.9
4	132	296	2.2	91	231	2.5
5	134	523	4.0	90	397	4.4
6	112	432	3.9	76	313	4.1
7	121	247	2.0	73	174	2.4
8	157	378	2.4	85	297	3.5
9	229	1035	4.5	120	901	7.5
10	186	722	4.2	145	572	4.0
11	160	512	3.3	110	363	3.3
12	143	327	2.3	102	175	1.7
M	150.1	459.0	3.1	98.4	348.5	3.6

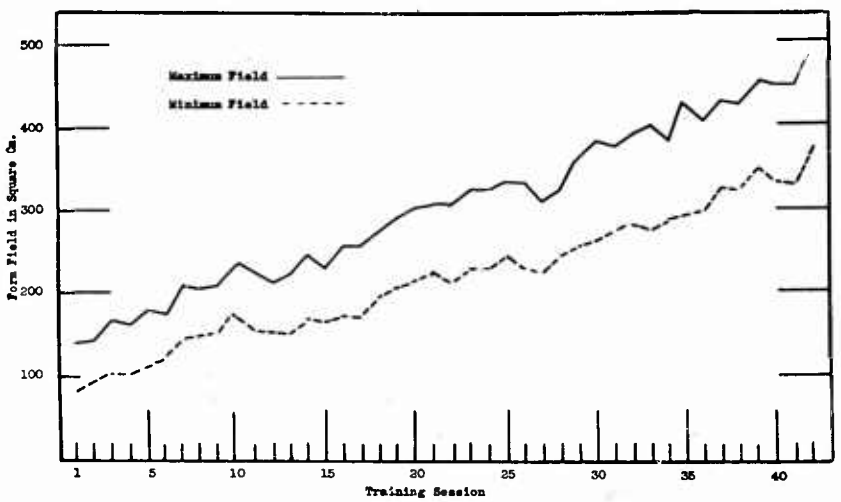

Figure 3. Perimeter Learning Curves

TABLE 5

PRETEST (I) AND POSTTEST (II) SCORES ON THE
DIAL CHECKING, PERIMETER, LANDOLT RING AND READING TEST, GROUP E-2

Subj. No.	Dial Checking I	Dial Checking II	Dial Checking G	Perimeter Test Average Field I	Perimeter Test Average Field II	Perimeter Test Average Field G	Landolt Rings Average Field II (Posttest only)
1	11	12	1	98	168	70	186
2	16	12	-4	125	242	117	153
3	11	17	6	65	175	110	126
4	9	17	8	65	120	55	201
5	13	13	0	79	432	353	173
6	7	2	-5	55	218	163	145
7	1	2	1	62	162	100	52
8	10	11	1	52	258	205	107
9	9	9	0	152	594	441	512
10	16	17	1	86	418	332	239
11	8	16	8	76	345	269	152
12	14	12	-2	71	222	151	116
M	10.4	11.7	1.3	82.2	279.3	197.2	180.2

READING TEST

Subj. No.	Form	Rate I	Rate II	Rate G	Accuracy I	Accuracy II	Accuracy G
1	R-C	214	214	0	77	88	11
2	C-R	337	382	45	59	77	18
3	---	---	---	---	--	--	--
4	C-R	116	145	29	53	44	-9
5	R-C	351	354	3	68	73	5
6	R-C	115	159	44	69	89	20
7	R-C	168	194	26	62	64	2
8	C-R	179	168	-11	55	38	-17
9	R-C	268	258	-10	76	58	-18
10	R-C	241	235	-6	63	77	14
11	R-C	225	354	129	46	37	-9
12	R-C	198	207	9	67	83	16
M		219.3	242.7	23.5	63.2	66.2	3.0

conclusion of the experiment: the University's Student Counseling Service had been giving him almost daily reading training on a reading accelerator. Even the inclusion of this specially trained subject does not succeed in producing a significant difference; in fact, his loss in reading accuracy on this particular reading test may be noted.

C. Control Group

Table 6 presents the pre- and posttest data for the control group, C-1. The only one of these measures to yield significant gains is the perimeter test in which mean improvement is highly significant (t is 5.49).

Table 7 shows the results of training in Group C-2, using black-on-white dials. The changes in number of correct items from one week to the next are seen to be quite irregular. The mean change from the combined results of the first three sessions, compared with the last three sessions, is not significant. It is clear that the limited amount of practice in dial checking, provided by a weekly test, does not succeed in improving the scores earned over the course of nine weeks. Table 8, showing the pre- and posttest data for this group, again reveals no significant trends.

D. Dial Check Reading Test

Table 9 presents the data for the biweekly dial checking tests made on all groups. No significant trends are noted. In terms of overall score for the four tests, Group C-2, actually trained on dial checking, does no better than the other groups.

A further inspection of individual scores on the Check Reading Test revealed that in one aspect the subjects had changed their behavior from the initial to the final test. On the initial test most subjects tended to mark the "null" responses much more often than on final test. For this reason, and because there were 8 opportunities for this one response to be correct, as compared with 2 chances for each other response, many more correct "nulls" are found on the first test than on the final. When these correct "null" responses are extracted from the data, the mean gains in each group become somewhat higher, being 1.8, 2.4, 3.9, and 3.3 for groups E-1, E-2, C-1 and C-2 in that order. Of these, the gains for Groups E-2 and C-1 are significant at the 5% level. This fact, that the untrained control group made the greatest numerical as well as a significant gain, does not seem to allow of much alteration in the general picture of little mean variation in relation to past training. Because the presence of the "null" response not only gave the subjects an easy way out when they were unsure of their responses, but also made establishment of a chance level of response difficult to evaluate, this slide will not be used in future experiments. Furthermore, because the number of correct items out of 80 possible responses was so low, it was decided that a 36-dial pattern was too difficult for a .10 second exposure, and for future experiments a 25-dial pattern will be used.

In a previous study, involving a group of 6 individuals who had had a considerable amount of form field training, compared with a group of six individuals with no such previous training, Christensen (1) found that some subjects of the control group with large form fields had actually had some

seemingly relevant experience, such as several years of piano playing. The biographical data obtained on the subjects of the present experiment were examined, and several individuals discovered who stated extensive experience with the piano, and in some cases, with other instruments. None of the scores, pretest, posttest or gains, of these individuals offered any suggestion that such previous experience had been effective as an agent in this experiment.

TABLE 6

PRETEST (I) AND POSTTEST (II) SCORES ON THE DIAL CHECKING, PERIMETER, LANDOLT RING AND READING TEST, GROUP C-1

Subj. No.	Dial Checking I	Dial Checking II	Dial Checking G	Perimeter Test Average Field I	Perimeter Test Average Field II	Perimeter Test Average Field G	Landolt Rings Average Field II (Post-test only)
1	11	12	1	52	77	25	81
2	16	15	-1	87	133	45	87
3	5	11	6	74	103	29	46
4	2	9	7	58	83	25	62
5	12	21	9	79	175	96	114
6	14	20	6	90	176	86	86
7	11	12	1	79	132	53	63
8	9	8	-1	58	84	26	82
9	13	14	1	86	139	53	79
M	10.3	13.6	3.2	73.7	122.4	48.7	77.8

READING TEST

Subj. No.	Form	Rate I	Rate II	Rate G	Accuracy I	Accuracy II	Accuracy G
1	C-R	170	178	8	75	100	25
2	R-C	233	274	41	64	71	7
3	C-R	200	195	-5	77	78	1
4	C-R	182	132	-50	80	71	-9
5	C-R	151	151	0	61	78	17
6	R-C	175	230	55	55	32	-23
7	C-R	200	300	100	68	61	-7
8	C-R	161	159	-2	83	74	-9
9	R-C	256	214	-42	80	76	-4
M		192.0	203.7	11.7	71.4	71.2	-.2

TABLE 7

NUMBER OF CORRECT RESPONSES ON
THE BLACK-ON-WHITE DIAL TEST, GROUP C-2

Subj. No.	Training Session 1	2*	3	4*	5	6*	7	8*	9
1	9	6	9	14	5	8	12	12	9
2	9	6	8	8	12	4	15	18	9
3	8	4	6	6	10	2	4	10	2
4	6	2	2	4	10	2	5	2	3
5	12	12	11	10	15	10	18	12	7
6	16	12	11	14	12	0	3	18	20
Sum	60	42	47	56	64	26	57	72	50

*On even-numbered sessions 40 items were used instead of 80; scores shown have therefore been doubled for convenience in comparison.

TABLE 8

PRETEST (I) AND POSTTEST (II) SCORES ON THE DIAL CHECKING,
PERIMETER, LANDOLT RING AND READING TESTS, GROUP C-2

Subj. No.	Dial Checking I	II	G	Perimeter Test Average Field I	II	G	Landolt Rings Average Field II
1	11	5	-6	77	99	22	91
2	8	12	4	71	81	10	--
3	11	6	-5	132	390	258	223
4	4	3	-1	108	143	36	204
5	12	23	11	71	177	106	72
6	13	16	3	93	152	59	74
M	9.8	10.8	1.0	92.0	173.7	81.8	132.8

READING TEST

Subj. No.	Form	Rate I	II	G	Accuracy I	II	G
1	R-C	150	177	27	68	60	-8
2	R-C	188	170	-18	57	80	23
3	C-R	187	165	-22	30	76	46
4	R-C	189	215	26	52	38	-14
5	C-R	276	240	-36	71	72	1
6	C-R	178	207	29	65	60	- 5
M		194.7	195.7	1.0	57.2	64.3	7.2

TABLE 9

NUMBER OF CORRECT RESPONSES ON THE
INTERMEDIATE DIAL CHECKING TEST (FORTY ITEMS), ALL GROUPS

Subj. No.	Intermediate Test 1	2	3	4	Sum	Intermediate Test 1	2	3	4	Sum
	Group E-1					Group E-2				
1	4	2	4	6	16	7	6	7	6	26
2	6	4	10	5	25	4	5	2	1	12
3	4	6	5	3	18	4	8	7	6	25
4	5	2	4	5	16	7	7	8	7	29
5	7	2	6	4	19	4	6	7	6	23
6	3	7	3	9	22	1	1	2	2	6
7	6	8	7	3	24	2	1	2	1	6
8	4	3	4	5	16	8	7	3	6	24
9	8	5	7	7	27	6	4	5	6	21
10	4	4	2	3	13	4	7	8	7	26
11	3	4	7	4	18	6	9	5	5	27
12	5	4	3	8	20	9	9	5	5	28
M	4.9	4.3	5.2	5.2	19.5	5.3	5.8	5.1	4.8	21.1
	Group C-1					Group C-2				
1	3	6	7	5	21	2	7	7	3	19
2	5	7	5	8	25	4	4	7	6	21
3	4	1	6	6	17	5	1	4	0	10
4	2	5	1	3	11	7	1	3	2	13
5	7	6	7	5	25	10	7	6	6	29
6	6	11	6	6	29	6	3	7	6	22
7	3	6	5	7	21					
8	2	3	8	5	18					
9	5	1	7	10	23	—	—	—	—	—
M	4.1	5.1	5.8	6.1	21.1	5.7	3.8	5.7	3.8	19.0

IV. DISCUSSION

The results of this experiment have been uniformly disappointing with regard to the possibility of a generalized improvement in ability to attend to objects not presented directly in the line of sight. The experiment does not succeed in rejecting totally the hypothesis that such training may sometimes be effective, but it is evident that the amount of such training needed would certainly have to be much more extensive than any used here. The three longest-trained groups in these experiments, for 40 or more sessions, spent almost exactly 20 hours apiece in training. Should the assumption be made that substantial results could be found only with training ten times as long, or 200 hours per man, it is evident that to give such training to 5000 individuals would require the use of a million man-hours. Before any organization such as the Air Force should launch a program of form-field training, it would therefore be necessary to know not only that the results of such training were substantial and highly generalized, but also that the improvement would endure and would occur in a large majority of the individuals trained.

It must be noted that the training systems studied here were of a highly simplified nature; the implications of this fact will be discussed below. It is possible that all or most subjects, when given such training, "discover" simple ways to improve their scores, such as attending to outstanding parts of the stimuli used. These responses may thus be responses to reduced cues, rather than actual improvements in the perception of the total objects themselves. This is, indeed, the explanation of similar experiments favored by Gibson (3) in her review of the literature on improvement of perceptual judgments. It is undeniable that the capacity to learn to respond to reduced cues is in itself a subject of interest, but it must be kept in mind that the basic problem of these studies concerns the transfer of training from a highly regulated and specific task to entirely different tasks with very practical aspects such as speed of reading, reading comprehension, and perception of peripherally visible airplane instruments. It may be well to formulate more precisely the requirements of any experiment which would reveal such transfer unequivocally.

1. There must be adequate control groups. An improvement in scores earned by an experimental group from pretest to posttest does not constitute evidence for improvement due to any intervening training. The scores on the posttest must be compared with those earned by a control group matched with the experimental group in all pertinent respects except that of the intervening training. Incidentally, such matching is not easily achieved. Certain psychological considerations must always receive attention. Perhaps the most important of these is motivation. It is always possible that the mere fact of having been selected to serve in an experimental group increases the motivation of the subjects. In experiments like these, subjects readily sense the practical value of successful training to read faster or perceive better. The control subjects may not merely be told: "Thanks for taking these tests. We shall call you back after a few weeks for more tests." If this is done, it may reduce their motivation to perform on the posttests. The control subjects have to be made to believe (and the information leading to this belief must be honestly given) that they are part of an ongoing program

so that their results may well lead to further use as subjects in subsequent and similar training experiments. At the same time, subjects of the experimental group must not approach the final tests with a feeling of being "let down" now that the experiment is ending. The writers believe that this problem was not of great importance in the studies reported here, because all of the subjects not only were paid, but also had ample opportunity to observe that other experiments were being conducted for which they could expect to be called as soon as openings were found for them. Such would not be the case in a program where there was an "air of finality" about the research.

2. The results must not be obtained from "subnormal" or other deviant groups. The reason is clear when one considers the phenomenon of statistical regression. If subjects are selected on the basis of a given pretest in such a way that their mean score is below the established norm on that test, it follows necessarily that their mean score on a repeat of the same (or a matched form) test will be higher -- unless, of course, the two tests are perfectly correlated. Disregard of this statistical consideration seems typical of many of the studies in which "flash training" is employed (2, 8). It should be added that when selected groups of this type are used it is unlikely that the statistical difficulty can be surmounted by the comparison of end-results of the experimental group with a similarly selected (and carefully matched) control group because, among other things, the proper test of the difference between the groups on posttest depends upon the pretest-posttest correlations, which should be identical for each group.

3. The transfer tests should be quite discrete, both logically and statistically, from the training task. In the case of peripheral vision training, for example, if the items of the posttest are much like those of the training task, an improvement in performance is to be interpreted merely as another step in the learning curve and not as a transfer phenomenon. This requirement actually creates a serious dilemma with regard to interpretation of posttest results which are based on perimetrically exposed items after perimeter training. If no improvement is found, then lack of transfer is readily postulated, but if some improvement is found, then it becomes necessary to demonstrate that the improvement is more than utilization by the subjects of the identical stimuli to which they responded in training. This makes it clear how important it is to use as posttests quite different tasks, such as reading, dial checking and the like. When "flash training" is used, it is quite evident that such training is in itself a kind of reading task. It should be a matter of little surprise if reading practice with tachistoscopically controlled exposure leads to some improvement in perceiving similar symbols when exposed in other ways. In this regard, it also becomes necessary to demonstrate that the tachistoscopic training yields posttest results which are at the very least as efficient as direct reading practice would be. As Gibson (3, pp. 418-419) states, there is little evidence from any carefully controlled studies that "flash training" has ever equalled the success of more direct methods. Again, the importance of finding transfer to discrete tasks must be emphasized.

The statements of the preceding paragraphs are meant to suggest that the positive effects of tachistoscopic and perimeter training are still a controversial issue in psychology, rather than an established fact. The experiments reported here do not negate the possibility that some sort of generalized and enduring transfer from such training may actually exist. On the other hand, these experiments do point to some of the difficulties which may be encountered in this type of research, and they also provide a basis for suggestions concerning the course which future research ought to take. One of the important factors to be investigated is the complexity of the training task. Specifically, and with regard to perimeter training, it is desirable to make the training stimuli much more elaborate, so that the possibility of learning to respond to reduced cues, as may be the case with a simple digit series, will no longer serve as an adequate explanation of the gradual improvement in peripheral acuity. An investigation along these lines is planned by the present writers.

V. SUMMARY AND RECOMMENDATIONS

Earlier experiments had suggested the possibility that training in tachistoscopic reading, or training in peripheral vision of objects, would lead to certain generalized improvements in such tasks as reading skill and utilization of extra-macular retinal areas for the perceiving of form. These experiments led to the hypothesis that a general expansion of the visual form field would be possible. The present study compared the effects of o· r 40 half-hour sessions of tachistoscopic training with a similar amount of perimeter training. None of the data substantiates an existence of generalized transfer to a reading task, the check reading of simulated aircraft instrument dials, or even to other peripheral visual tasks except when the test task is very similar to the training task. The most reasonable hypothesis at present seems to be that the improvements demonstrated in the training tasks are the result of the subjects' capacity for learning to notice minute elements of the stimulus pattern.

Two recommendations appear to follow from these considerations: (1) it would be unwise for the Air Force to embark on any expensive or large-scale program of tachistoscopic or perimetry training without much more substantial evidence that such training is really beneficial; (2) in view of the fact that any truly successful training program of this nature would be of wide applicability, further research along the lines indicated is planned and should be undertaken.

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APPENDIX I*

DIRECTIONS FOR THE DIAL CHECK READING TEST

1. (Paragraph 1—How to operate the specific type of projector, is omitted from this appendix.)

2. Two subjects are tested at a time. Each subject is seated at one side of the projector in the specified location, 28 inches from the screen. The slides are piled in the specified order beside the projector. The size of the dial on the screen is 1 3/4 inches. The center of the exposure field is at the level of the subjects' heads (approximately). In the following instructions, all statements in CAPITALS are read to the subjects. Pass out the prepared answer booklet to each subject.

3. IT IS THE PURPOSE OF THIS TEST TO SEE HOW WELL YOU ARE ABLE TO CHECK READ SIMULATED AIRCRAFT INSTRUMENT DIALS. (Turn on projector, expose the Null slide.) NOTICE THAT EACH OF THE THIRTY-SIX POINTERS IS NOW INDICATING THE SAME READING OF THIRTY-SEVEN AT APPROXIMATELY THE NINE O'CLOCK POSITION. (Turn off the projector.) DURING SOME OF THE TRIALS THE POINTER OF ONE OF THE THIRTY-SIX DIALS WILL BE POINTING AT FORTY OR APPROXIMATELY THE TEN O'CLOCK POSITION, LIKE THIS. (Turn on projector, expose Slide 12.) IT WILL BE YOUR JOB TO INDICATE ON YOUR ANSWER SHEET WHICH POINTER, IF ANY, IS DEVIATING FOR EACH EXPOSURE. ON THE SLIDE YOU ARE NOW OBSERVING, THE DIAL WITH THE DEVIATING POINTER IS IN THE THIRD ROW AND THIRD COLUMN. (Turn off projector and pass out sample answer slip, a row of items cut from an answer sheet.) TO MARK THE ITEM YOU HAVE JUST SEEN YOU WOULD MAKE AN X ON THE LITTLE CIRCLE IN THE THIRD ROW AND THIRD COLUMN. DO THIS NOW ON THE LITTLE SLIP I HAVE JUST GIVEN YOU. (Make sure the subjects make proper X's.)

4. REMEMBER, NONE OR ONE, BUT NEVER MORE THAN ONE POINTER MAY BE DEVIATING FOR ANY ONE TRIAL. WE WILL NOW HAVE TWO PRACTICE TRIALS. WHEN I SAY READY DIRECT YOUR ATTENTION TO THE CENTRAL AREA OF THE SCREEN. WHEN I SAY NOW I SHALL SHOW THE SLIDE. SINCE THE PROBLEM ORDERS ARE SELECTED AT RANDOM, YOU WILL BE BEST PREPARED IF YOU WILL DIRECT YOUR ATTENTION TO THE CENTRAL AREA OF THE SCREEN EACH TIME I SAY READY.

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* The writers would like to present their reason for recording the detailed procedures of their experiment in this and the following appendices. The results of this report are quite dissimilar to those which previous investigations, cited in this report, would have led one to expect. In the case of such divergence, it seems appropriate that the present investigators should make known the details of their methods. This information may aid other investigators in setting up experiments which may arrive at a reconciliation of the discrepancies among these and other studies.

5. Practice trial 1 - Slide 24. Close the shutter: press setter lightly again, then exposure lever. Place slide 24 in position. Turn on projector. Press setter down.

6. READY, NOW (On the word NOW press exposure lever, allow about 5 sec. for writing answer.) THE CORRECT ANSWER WAS ROW THREE COLUMN FOUR. YOU SHOULD HAVE MARKED THIS IN YOUR SECOND ITEM ON THE SMALL SLIP. DID YOU BOTH GET THIS ITEM? (Say the following if either subject missed the item: VERY WELL. I SHALL EXPOSE IT AGAIN. WATCH CAREFULLY. READY....NOW.) NOW WE SHALL HAVE A SECOND PRACTICE TRIAL. (slide Null) READY..NOW. THE CORRECT ANSWER WAS NONE. IN THE THIRD ANSWER SPACE ON THE LITTLE SLIP YOU SHOULD HAVE MARKED AFTER THE WORD NONE. (Check that both subjects are handling the answer slips correctly, and then take the slips away.)

7. NOW WE SHALL BEGIN THE TEST ITSELF. NOTICE THAT THE ITEMS ARE NUMBERED ACROSS THE ANSWER SHEET. YOU MUST MARK ONE OF THE DIALS OR THE WORD NONE ON EVERY ITEM. IF YOU ARE NOT SURE, GUESS, EVEN IF YOUR GUESS IS PURELY CHANCE. ANY QUESTIONS? THIS IS ITEM ONE. READY.....NOW.

8. THIS IS ITEM TWO. READY.....NOW (Etc. saying the item number every time.)

APPENDIX II

INSTRUCTIONS FOR PERIMETER TEST

1. The subject is seated before the perimeter. No. 9 is exposed at R.24°. Upper screen is in place.

2. THIS IS A TEST OF YOUR ACUITY AT THE PERIPHERY OF YOUR EYE. DURING THE TEST, ONLY ONE EYE WILL BE USED AT A TIME. THE OTHER EYE WILL BE KEPT COVERED WITH THIS SHIELD. WE SHALL TEST EYES ALTERNATELY SO AS NOT TO TIRE YOUR EYE. I SHALL SET A NUMBER FROM ONE TO NINE IN THIS OPENING. NUMBER NINE IS NOW SHOWING. THEN WHILE YOU LOOK STRAIGHT AHEAD, I SHALL EXPOSE THE NUMBER FOR ABOUT A SECOND LIKE THIS. (Demonstrate with wand.) I SHALL ALWAYS GIVE A READY SIGNAL BEFORE I SHOW YOU THE NUMBER.

3. THE WAY TO LOOK STRAIGHT AHEAD DURING THE EXPOSURE IS TO PUT YOUR CHIN ON THIS CHINREST AND ADJUST IT SO THAT YOU CAN SEE YOUR OWN EYE CENTERED DIRECTLY IN THE MIRROR. (At this point help subject with shield over left eye, and adjust correctly to right eye.) ARE YOU SET RIGHT NOW? THIS IS THE WAY IT WILL GO. STARE STEADILY AT YOUR EYE IN THE MIRROR. READY. (Expose number Nine.)

4. I SHALL NOW EXPOSE UP TO THREE DIFFERENT NUMBERS AT THIS POINT. IF YOU MISS ONE OF THEM, I SHALL MOVE IN A LITTLE AND TRY AGAIN. I SHALL MOVE IN UNTIL YOU GET THREE NUMBERS WITHOUT AN ERROR. THEN I SHALL MOVE IN EVEN MORE AND START OUT AGAIN UNTIL YOU MISS ONE. ANY QUESTIONS? (Expose numbers according to system on back of screen. If subject moves his eye, say: I THINK YOUR EYE MOVED A LITTLE THAT TIME. TRY TO STARE STRAIGHT AHEAD. Then expose a new number.)

5. Continue in by two degree steps until subject gets three right. Then come in four degrees and start out. It is not possible to go below 10°. If subject gets in this far, it covers the mirror on the right side, or overhead. Have subject fixate the little rivet on the scale in this case. If subject fails to get 3 out of 3 at 10°. record score as "8". Note also that temporal measures often run into the blind spot where the subject sees nothing at all. Blind spot is usually someplace around 14° - 18°R for right eye, 14° - 18°L for left eye. Most subjects have no form field beyond this spot when first tested. Record the last position on the way out at which subject gets three right.

6. NOW WE SHALL TEST YOUR LEFT EYE. CHANGE THE SHIELD OVER TO THE RIGHT EYE AND MOVE YOUR HEAD TO THE OTHER SIDE OF THE CHINREST. (Test the left eye in the same manner, starting at 24° and moving in by two degree steps.)

7. NOW WE SHALL TEST THE OTHER SIDE OF YOUR RIGHT EYE. CHANGE THIS PATCH AND MOVE YOUR HEAD OVER. (Move the scale over the L perimeter and test.)

8. NOW THE LEFT EYE.

9. NOW WE SHALL TEST THE UPPER PART OF EACH EYE. THE RIGHT EYE FIRST. (Swing the perimeter to the vertical. and change the numbers to the other set for vertical exposures.)

10. NOW THE LEFT EYE.

11. NOW WE SHALL TEST THE LOWER PART OF EACH EYE. THE RIGHT EYE FIRST. (Make the necessary perimeter shift by placing the scale at the bottom.)

12. AND NOW THE LEFT EYE. (When done, allow the subject to look at his scores. If he asks what the average is, tell him we are now finding that out for this special device with numbers, which is being used for the first time.)

APPENDIX III

INSTRUCTIONS FOR THE TACHISTOSCOPIC TRAINER

1. On the first day, there will be a booklet ready, for keeping the results, with the subject's name on it. Each subject will have his own individual booklet. Booklets will be kept in the drawer of the desk on which the tach trainers sit.

2. Seat the subjects before the trainer, with the barrier away, and have them first read to themselves the special written instructions to subjects. When both are finished, say:

THE WAY THE TRAINER WORKS IS THIS: YOU TAKE A STACK OF CARDS AND PLACE THEM IN THIS HOLDER. (Demonstrate with five threes.) THEN YOU MOVE

THIS LITTLE LEVER FORWARD AND THAT PULLS THE LAST CARD BACK. (Demonstrate). IT SHOULD THEN FALL INTO THE SLOT, BUT IT MAY STICK. A LITTLE TAP LOOSENS IT. (Demonstrate as necessary.) NEXT YOU SET THE TRAINER BY TURNING THIS KNOB ON THE FRONT. NEVER TOUCH ANYTHING EXCEPT THIS KNOB, OR YOU MAY SET THE WORKS SO THAT THE MACHINE WILL NOT OPERATE. TURN IT ALL THE WAY UNTIL IT CLICKS. (Demonstrate.) NOW YOU ARE READY TO EXPOSE THE FIRST NUMBER. TO DO THIS, SIT THE WAY IT TELLS YOU TO IN THE INSTRUCTIONS YOU HAVE READ, WITH YOUR HEAD A FEW INCHES FROM THE OPENING. THEN PULL THIS LITTLE KNOB OUT. (Point to knob.) THIS WILL EXPOSE THE NUMBER FOR A BRIEF PERIOD. THE NUMBERS IN THIS SERIES HAVE THREE DIGITS. GET SET AND TRY THIS FIRST ONE. (Let both subjects run their first number.)

NOW WRITE THE NUMBER THAT YOU SAW HERE IN THIS BOOKLET IN THIS COLUMN. (Point to proper place.) TO CHECK WHETHER YOU WERE CORRECT, PRESS THIS BUTTON. (Point.) WRITE THE NUMBER YOU NOW SEE IN THE SECOND COLUMN. NOW GO AHEAD AND RUN THE REST OF THE CARDS IN THE SAME MANNER.

3. When the subjects have finished the five cards, mix them a little and put them back in the slot. Do this twice, so that 15 cards are run. Then say:

NOW WE SHALL GO TO FOUR DIGIT NUMBERS. HERE ARE FIFTEEN CARDS. PUT THEM IN THE HOLDER YOURSELF. WHEN YOU HAVE RECORDED THESE FIFTEEN, CHECKING EACH ONE AS YOU GO ALONG AND WRITING BOTH WHAT YOU SEE IN THE FIRST COLUMN OF THE PAIR OF COLUMNS, AND WHAT THE NUMBER REALLY IS IN THE SECOND COLUMN, GO ON AND DO THIS STACK (point) OF FIFTEEN FIVES. THAT WILL END YOUR SESSION FOR THE DAY. WE SHALL GRADUALLY WORK UP TO HIGHER NUMBERS BY REMOVING FROM THE BOTTOM OF THE SERIES EACH DAY THE LOWEST GROUP, IF YOU GOT AT LEAST TWELVE OF THEM RIGHT.

4. On subsequent days it is necessary only to note what should be set out for the subject to work with, to make sure he used just those cards, and does not do more nor less than the amount scheduled.

DIRECTIONS TO TACHISTOSCOPIC TRAINEES

It has been conclusively demonstrated that a person can be trained to perceive large numbers of digits or other perceptual patterns in a very short time. This ability seems to be correlated positively with other visual tasks, such as speed of reading and degree of comprehension of material read.

The experimenter has demonstrated how to operate the trainer and record your results. However, experience has shown that careful attention to a few details will enable you to make more rapid progress in this training. It will be to your benefit to observe these rules.

1. Don't take more training each day than is prescribed. This usually causes one to "tense up", and does more harm than good.

2. When you release the shutter, be relaxed. Do not stare intently at the dull red fixation cross at the instant of release. If you do, this will result in your seeing the one or two digits behind the cross very clearly, but you will see little of the other digits. Instead, use this dull red cross as a sort of reference guide, so you will know approximately where the center of the line of digits will appear. Be relaxed and try to acquire the feeling that your entire eye and not just a small portion of it is opened and ready to receive the digits.

3. Immediately after the exposure, sit still a moment with your eyes open. Try to organize what you saw. Don't, above all, start immediately to write down the digits. This will sometimes work for the short lists (3-5 digits), but you will find for the longer lists that you will have forgotten the later digits in your hurry to record the first digits. Organize what you saw; then record it.

4. During your training all of you will reach periods where apparent progress is dishearteningly slow, for example, you may become "stuck" on five digits lists for two weeks. Do not become discouraged. If you keep trying, you will find one day that "fives" are as simple as "threes" used to be.

5. As training advances, your errors will sometimes take on consistent patterns. For example, an exposure of 17346 will be read as 17436. Do not attempt to outguess yourself by recording a 17346 even though you really saw 17436. Such difficulties will eventually clear up, and you will be more adequately prepared for the more difficult lists to come.

6. The upper limit of human ability at this task is as yet unknown. It is on record that some college students have been trained to the point where they could repeat without error a list of about 20 digits exposed for a fraction of a second. There is no known correlation between intelligence and this ability. Any student without a physical visual defect is capable of improving his perceptual abilities through training such as this.

APPENDIX IV

INSTRUCTIONS FOR PERIMETER TRAINING

1. Subject is seated before the perimeter. The wood blocks have been removed from the perimeter scale.

2. On the first training session say: THIS IS SOMETHING LIKE THE TEST YOU TOOK THE OTHER DAY. FROM NOW ON, HOWEVER, WE ARE GOING TO SEE HOW FAR OUT YOU CAN LEARN TO SEE THE NUMBERS. IT HAS BEEN FOUND THAT TRAINING OF THIS SORT DEFINITELY INCREASES THE SIZE OF THE VISUAL FIELD IN WHICH YOU SEE

FORM. IT IS ALSO KNOWN THAT FAST READERS AND ACCOMPLISHED MUSICIANS TEND TO DEVELOP WIDE FORM FIELDS. FOR MANY PEOPLE WHO ARE GIVEN PRACTICE LIKE THIS THERE TENDS TO BE CONSIDERABLE IMPROVEMENT IN READING SPEED AS WELL AS COMPREHENSION OF THE MATERIAL READ. THE NUMBERS WILL BE EXPOSED MUCH AS THEY WERE LAST TIME, EXCEPT THAT WE SHALL ALWAYS WORK FROM INSIDE TOWARD THE PERIPHERY, AND I SHALL WIGGLE EACH NUMBER A LITTLE DURING EXPOSURE LIKE THIS. (Demonstrate by wiggling back and forth twice in about one second.)

3. WE SHALL BEGIN WITH THE RIGHT SIDE OF THE RIGHT EYE. PUT ON THE SHIELD AND ADJUST YOUR HEAD.

4. The starting point will always be four degrees in from the score of the previous session, unless score was 10^{0}, in which case, we shall start at 10^{0}. Steps will always be by 2 degrees and will go out with three exposures at each position until subject misses one. Score will be highest degrees with all three right. Order of eyes is always the same. Subject is permitted to see his results at the end of the session.